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Original Research Article

Performance of the Iranian Currency Exchange Using Dynamic Conditional Correlation

Mohammad Qezelbash* **Amir Hamooni†**
Saeid Tajdini‡ **Davood Arghavan§**

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The aim of this study was to assess the performance of the Iranian currency exchange market by analyzing the dynamic conditional correlation (DCC) between the Iranian currency exchange rate and the free market exchange rate of the US dollar in Iran. This analysis was conducted for both the same day and with a one-day lag, spanning from June 20 to October 30, 2022. The results of the study indicate that the DCC for concurrent days (denoted as dcc0) stood at 48%. Meanwhile, the DCC for the Iranian currency exchange rate with a one-day delay compared to the free market US dollar exchange rate in Iran (referred to as dcc+1) was 17%, and the DCC for the free market US dollar exchange rate with a one-day lag behind the Iranian currency exchange rate (referred to as dcc-1) was 35%.

Keywords: Dynamic Conditional Correlation, Iranian Currency Exchange, Monetary Policy
JEL Classification*:* G10, G20, G28

1 Introduction

Research into the effectiveness of monetary policies has been a focal point of academic inquiry since the 1970s. Central banks commonly employ both expansionary and contractionary monetary policies, often manipulating interest rates and various financial tools to implement these strategies. In the specific context of Iran, a complex multi-rate currency system, which includes the Iranian currency exchange rate in comparison to the free market US dollar rate, has been necessitated by the enduring economic sanctions. Determining

* Faculty of Economics, Allameh Tabataba'i University, Tehran, Iran; Ghezelbash@ice.ir
†Faculty of Economics, University of Tehran, Tehran, Iran; Hamooni@ice.ir
‡ Faculty of Economics, University of Tehran, Tehran, Iran; Saeidtajdini@ut.ac.ir.
§ Faculty of Economics and Management, University of Semnan, Semnan, Iran; Davood.arghavan@alum.semnan.ac.ir (Corresponding Author)

and stabilizing exchange rates is a fundamental economic objective for all nations, and the Iranian currency exchange market serves as a crucial benchmark for achieving this objective.

Notably, despite the significance of the Iranian currency exchange market, there remains a conspicuous dearth of scholarly exploration on this subject. As a result, the present paper seeks to fill this research gap by examining the performance of the Iranian currency exchange. This investigation hinges on the dynamic conditional correlation between Iran's free market US dollar rate and the Iranian currency exchange dollar. The study spans the period from June 20 to October 30, 2022, scrutinizing this relationship both on the same day and with a one-day interval. The primary goal is to discern variations in the dynamic conditional correlation under these two scenarios, thus delivering a comprehensive comprehension of the Iranian currency exchange market's performance.

To accurately measure the performance of the Iranian currency exchange, this research employs dynamic conditional correlation methodology. The study is divided into five sections for ease of presentation. Section 1 provides an introduction to the research background. Section 2 offers an overview of relevant literature. Section 3 describes the methodology chosen for the study. Section 4 presents the research results, while Section 5 provides the study's conclusion.

2 Literature Review

2.1 Dynamic Conditional Correlation

The estimation and prediction of time-dependent covariance matrices of asset returns play a pivotal role in various financial applications, including asset allocation, risk management, and the assessment of systemic risk. Over the years, Engle's (2002) GARCH-DCC methodology has emerged as a prominent paradigm in financial literature, esteemed for its adaptability and forecasting accuracy (Engle and Sheppard, 2001). In a nutshell, the GARCH-DCC approach involves the separate modeling of conditional variance and conditional correlation matrices (Engle, 2002; Engle & Sheppard, 2001). Conditional variance is typically captured through GARCH modeling, while the conditional correlation matrix is established using the dynamic conditional correlation (DCC) model. Recent contributions to the GARCH-DCC-based literature encompass works by Brownlees and Engle (2017), De Nard et al. (2021), Engle et al. (2019), and Van Os and Van Dijk (2021).

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Zhang (2006) conducted a comprehensive analysis of forecasting models for the Shanghai and Shenzhen indices of the China Stock Exchange, utilizing moving average models, exponential moving averages, random walks, and various GARCH models. His findings indicated that no single model consistently outperforms the others in all conditions. Notably, asymmetric models such as GJRGARCH and EGARCH exhibited superior performance for the Shenzhen index, while they were deemed less suitable for predicting conditional risk in the Shanghai index.

Abdelaal (2011) delved into the prediction of volatility in Egyptian stock exchanges over a substantial period from 1998 to 2009. His research found that the EGARCH model excelled in forecasting volatility compared to other models.

Liu and Hung (2010) explored the S&P index, testing EGARCH, GARCH, ARCH, and GJR-GARCH models. Their investigation highlighted the significance of asymmetric models, particularly GJR-GARCH and EGARCH, in predicting volatility. They underscored that the type of error distribution was less crucial for improving volatility predictions.

Dritsaki (2017) extended the analysis to daily stock returns on the Stockholm Stock Exchange, concluding that asymmetric GARCH models, especially the EGARCH model coupled with the ARIMA (0, 0, 1) model, yielded more precise forecasts.

Andreea et al. (2017) investigated the euro's exchange rate volatility against the Romanian currency. Their research demonstrated that asymmetric models like EGARCH and PGARCH outperformed symmetric GARCH models in estimating risk and return.

Several studies by Guo (2017), Sarkar and Banerjee (2006), Intaz et al. (2016), Coffie et al. (2017), and Dritsaki (2017) examined different stock exchanges and reinforced the superiority of asymmetric GARCH models, including GJRGARCH and those accounting for leverage, in risk forecasting compared to symmetric GARCH models.

Muntazir et al. (2017) explored the relationship between crude oil prices and exchange rates in 12 Asian countries. Their empirical findings suggested a weak negative correlation between oil prices and exchange rates in most Asian countries.

Yoshihiko et al. (2017) investigated correlations among East Asian stock markets, such as Japan, Singapore, and Hong Kong, and the US stock market, employing a dynamic conditional compensation model .They concluded that the Singapore and Hong Kong markets exhibited significant correlations with

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the global market, especially the US market, whereas the Japanese market had a limited impact on East Asian markets.

Robiyanto (2018a, 2018b) delved into the dynamic correlation between ASEAN-5 stock markets and global oil prices, as well as the dynamic integration of Indonesian stock markets with Asian and global stock markets, offering valuable insights into the interconnectedness of these financial domains.

Over the past two decades, academic research has focused on assessing whether companies with good ESG performance deliver better financial returns to investors (Cortez et al. 2009; Geczy et al. 2005; Harrison and Marcin 2009; Hoti et al. 2007; Opler and Sokobin 2005). However, there have been sporadic efforts to realize and predict the volatility of socially responsible investment indices (Sadorsky 2014). Also, until now, no literature has compared the conditional volatilities of SRI indices with those of common indices. Existing literature emphasizes the dynamic conditional correlation (GARCH) (DCC-GARCH) model as suitable for studying volatility contagion in financial markets (Pelletier 2006; Kenourgios et al. 2011; Syllignakis and Kouretas 2011). Engle (2002) confirms that the DCC model is the appropriate technique because it provides reasonable estimates of the correlation process (Engle, 2002). Correspondingly, Laurent et al. (2012) examine the selection of the most appropriate multivariate GARCH model and prove that DCC analysis provides better predictions (Laurent et al., 2012). In addition, Sadorsky (2014) compares DJSI of socially responsible companies, gold prices, and oil price using his three multivariate GARCH models and finds that the DCC model best fits the data to compute dynamic conditional correlations (Sadorsky, 2014). Tajdini et al. (2019, 2021) measured the performance of stock market indices using conditional risk and justified beta and showed that the insurance index performed better than other indices of the Tehran stock exchange.

2.2 Monetary Policy

Monetary policy is a powerful tool that can be used to influence economic activity and promote stability in an economy. The central bank of a country, such as the Federal Reserve in the United States, has the authority to implement monetary policy to achieve specific macroeconomic goals, such as price stability, full employment, and economic growth. The primary objective of monetary policy is usually to maintain price stability, which means keeping inflation under control. When prices rise too quickly, it can lead to several negative effects, such as reduced purchasing power for consumers, increased

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uncertainty for businesses, and decreased economic growth. To combat inflation, the central bank may increase interest rates, which makes borrowing more expensive and reduces the amount of money available for spending.

Conversely, during an economic downturn characterized by high unemployment, central banks often employ expansionary monetary policy measures to stimulate economic growth and job creation. One of the primary tools in this arsenal is the reduction of interest rates. Lowering interest rates makes borrowing more affordable and increases the available funds for spending and investment, which in turn can boost economic activity.

Open market operations are another essential tool within the realm of monetary policy. In these operations, the central bank engages in the purchase or sale of government securities in the open market, effectively manipulating the quantity of money circulating in the economy. When the central bank purchases securities, it injects additional money into the economy, whereas selling securities has the opposite effect, withdrawing money from circulation.

In addition to interest rates and open market operations, central banks may also utilize reserve requirements and discount rates to shape the behavior of banks and borrowers within the economy. Reserve requirements dictate the minimum reserves that banks must maintain, which, in turn, impacts their capacity to lend money. Meanwhile, discount rates refer to the interest rates banks pay when borrowing from the central bank, and alterations to these rates can influence the cost of borrowing for both consumers and businesses.

Overall, monetary policy is an important tool for promoting economic stability and achieving macroeconomic goals. However, central banks need to exercise caution when implementing monetary policy, as excessive intervention can lead to unintended consequences, such as asset bubbles or currency instability. Therefore, central banks must carefully balance the benefits of using monetary policy with the potential risks.

Monetary policy is a crucial tool that central banks use to influence economic activity and promote stability. One of the primary objectives of monetary policy is to maintain price stability, which means keeping inflation under control through measures such as interest rate adjustments and open market operations. However, while short-term monetary policy can effectively stabilize the economy during business cycles, it may not be as effective in addressing longer-term structural issues such as demographic changes, technological advancements, or shifts in global trade patterns, as observed by Rachel and Smith (2018) in their research.

Rachel & Smith (2018) explores the relationship between monetary policy and long-term economic trends. They argue that while short-term monetary policy can effectively stabilize the economy during business cycles, it may not be as effective in addressing longer-term structural issues such as demographic changes, technological advancements, or shifts in global trade patterns. Their research provides evidence that monetary policy can have an impact on long-term trends, but this impact is limited and uncertain. They suggest that policymakers should consider a broader range of tools beyond short-term interest rates, such as macro-prudential regulation and fiscal policy, to address long-term trends. Furthermore, they analyze the challenges that central banks face when trying to navigate long-term trends. It notes that central banks must balance the need for stability in the short term with the potential risks associated with prolonging unsustainable economic trends. Overall, their research highlights the importance of considering both short-term and long-term factors when designing and implementing monetary policy. It argues that policymakers should adopt a more comprehensive approach that takes into account the broader economic context and long-term trends to promote sustainable economic growth. (Rachel & Smith 2018).

Furthermore, Mishkin's research highlights the impact of monetary policy on asset prices, which can influence financial stability. Policymakers must carefully monitor these risks and consider using macro-prudential tools to mitigate potential risks.

Mishkin (2020) examines the impact of monetary policy on asset prices, such as stock prices and real estate values. Research showed that monetary policy can influence asset prices through several channels, including its effect on interest rates, inflation expectations, and investor sentiment. Mishkin (2020) reviews the literature on the relationship between monetary policy and asset prices, noting that empirical evidence is mixed. Some studies suggest that monetary policy has a significant impact on asset prices, while others find little or no effect. Mishkin (2020) also discusses the potential risks associated with monetary policy's impact on asset prices, such as the creation of asset bubbles or increased financial instability. He suggests that policymakers should monitor these risks carefully and consider using macro-prudential tools, such as capital requirements or loan-to-value ratios, to address them. He emphasizes the importance of understanding the linkages between monetary policy and asset prices to promote economic stability and growth. It suggests that policymakers should take a cautious approach when using monetary policy to influence asset prices and be prepared to use other tools if necessary to mitigate potential risks (Mishkin, 2020). Similarly, Cecchetti and Schoenholtz (2018) point out the importance of understanding how banks respond to changes in monetary policy to promote a stable and resilient banking system.

Cecchetti and Schoenholtz (2018) discusses the impact of monetary policy on the behavior of banks, particularly in light of the 2008 financial crisis. Cecchetti and Schoenholtz (2018) argue that the crisis highlighted the importance of understanding how banks respond to changes in monetary policy. Their research examines the channels through which monetary policy affects banks, such as its impact on interest rates, lending standards, and liquidity conditions. The authors also discuss the role of regulatory policies, such as capital requirements and stress tests, in shaping bank behavior. Their research analyzes the challenges that policymakers face when trying to use monetary policy to influence bank behavior. The authors note that while monetary policy can be effective in promoting economic growth and stability, it can also have unintended consequences, such as encouraging excessive risk-taking by banks. Their finding emphasizes the importance of taking a comprehensive approach to monetary policy that considers its impact on both the broader economy and the behavior of individual banks. It suggests that policymakers should carefully monitor the behavior of banks and consider using a range of tools, including macro-prudential regulation and targeted lending facilities, to promote a stable and resilient banking system (Cecchetti and Schoenholtz, 2018).

In another research, Gali (2018) examines the role of fiscal and monetary policies in stabilizing the US economy during and after the Great Recession. He argues that while both policies played a critical role in promoting economic recovery, they had different strengths and weaknesses. The article discusses the limitations of monetary policy in addressing the depth and severity of the recession, particularly given that interest rates were already near zero at the onset of the crisis. The author suggests that fiscal policy, including targeted government spending and tax cuts, was more effective in providing a stimulus to the economy. Furthermore, he analyzes the challenges that policymakers face when coordinating fiscal and monetary policies. The author notes that these policies can have complementary or conflicting effects on the economy, and coordination is necessary to ensure a coherent policy response. His research emphasizes the importance of considering both fiscal and monetary policies when designing an effective stabilization policy. It suggests that policymakers should be prepared to use a range of tools, including unconventional monetary policies and automatic stabilizers, to promote economic stability and growth.

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In some cases, unconventional monetary policies like quantitative easing (QE) have been used to stimulate economic growth, but they can have significant effects on global financial markets and require careful consideration of international dimensions when designing and implementing them, as noted by Yoldas (2018). Yoldas (2018) examines the impact of unconventional monetary policies, such as quantitative easing (QE), on international stock markets. He argues that these policies had significant effects on global financial markets, particularly in terms of increasing asset prices and reducing risk premiums. The article reviews empirical studies that analyze the transmission channels through which unconventional monetary policies affect international stock markets. It notes that the impact varies across countries and sectors, depending on factors such as trade relationships, exchange rate regimes, and financial market structures. He highlights the importance of considering the international dimensions of monetary policy when designing and implementing unconventional policies. It suggests that policymakers should be mindful of the potential spillover effects of their policies on global financial markets and work collaboratively to promote economic stability and growth.

However, in severe financial crises like those faced by economies with sanctions, conventional monetary policy measures may not be enough. Countries may be forced to adopt multi-rate exchange rate systems to navigate the crisis, as seen in Iran. In such situations, policymakers must carefully balance short-term stabilization goals with the potential long-term risks associated with prolonged unsustainable economic trends. Overall, a comprehensive approach that considers both short-term and long-term factors is necessary to promote sustainable economic growth and stability.

3 Methodology

The Conditional Heteroskedasticity Variance model, an econometric tool, is employed to analyze and forecast the volatility and turbulence in asset returns using ARCH models.

The model GARCH (p, q), in which p shows σ_{t-1}^2order or variance of the previous day, and q shows the power of ε_{t-1} or the disruptive component of the previous day in this model.

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$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i} + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$$

4 Research Results

4.1 Constant Conditional Correlation (CCC)

Initially, the conditional variance of assets is calculated using the GARCH model.

Standardization of returns by dividing returns by their standard conditional deviations and then calculating the constant conditional correlation coefficient between assets using standardized returns.

$$p_{ij} = \frac{q_{ij}}{\sqrt{q_{ii}\, q_{jj}}}$$

4.2 Dynamic Condition Correlation (DCC)

The process begins with the computation of conditional asset variances through the GARCH model. Afterward, returns are standardized by dividing them by their respective standard conditional deviations. Subsequently, the constant conditional correlation coefficient between assets is calculated using these standardized returns.

$$p_{ij,t+1} = \frac{q_{ij,t+1}}{\sqrt{q_{ii,t}\, q_{jj,t+1}}}$$

To calculate the dynamic conditional covariance, $q_{ij,t+1}$, one can use the exponential method or GARCH model.

$$q_{11,t} = (1-\lambda)\left(z_{1,t-1}\, z_{1,t-1}\right) + \lambda q_{11,t-1}$$
$$q_{22,t} = (1-\lambda)\left(z_{2,t-1}\, z_{2,t-1}\right) + \lambda q_{22,t-1}$$
$$q_{12} = (1-\lambda)\left(z_{1,t-1}\, z_{2,t-1}\right) + \lambda q_{12,t-1}$$

To find the coefficients, the MLE method can be utilized via following target function:

$$L_c = -\frac{1}{2}\sum^{T} \left(\ln\left(1 - p_{12,t}^2\right)\right) + \frac{\left(z_{1,t}^2 + z_{2,t}^2 - 2p_{12,t} z_{1,t} z_{2,t}\right)}{\left(1 - p_{12,t}^2\right)}$$

Where the dynamic conditional correlation coefficient is calculated using the following equation.

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$$p_{12,t} = \frac{q_{12,t}}{\sqrt{q_{11,t}\, q_{22,t}}}$$

Here's the edited text in academic format:

The innovative aspect of this study is the use of dynamic conditional correlation to monitor the performance of the Iranian currency exchange. The objective of this research was to examine the convergence of the Iranian currency exchange market dollar with Iran’s free dollar market from June 20 to October 30, 2022. To accomplish this goal, the dynamic conditional correlation between these two-time series was analyzed both simultaneously and with a one-day gap.

4.3 Finding

To measure the dynamic conditional correlation between the two-time series of Iran’s free market dollar and the Iranian currency exchange dollar, we first examined the conditional risk of each using the GARCH.

As shown in Table 1, to calculate dynamic conditional correlation, the conditional risk was first measured using GARCH (1,1) model.

Table 1
GARCH

	α	**β**
Iran’s free market dollar	0.08*	0.81*
P-value	0.041	0.000
Iranian currency exchange dollar	0.9*	0.48*
P-value	0.000	0.000

Anywhere coefficients α and β are significant. The symbol * denotes significance at the 5% levels
Source: Research Findings

As illustrated in Table 2 and Figure 1, the average dynamic conditional correlation between Iran’s free market dollar and the Iranian currency exchange dollar at the same time was 48% (dcc0). The dynamic conditional correlation of Iran’s free market dollar with a one-day delay in Iran's currency exchange market was approximately 35% (dcc-1), while the dynamic conditional correlation of the Iranian currency exchange market with Iran’s free dollar market one day later was almost 17% (dcc+1).

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Table 2
Average dynamic conditional correlation between Iran's free market dollar and the Iranian currency exchange dollar

Dcc0	**Dcc+1**	**Dcc-1**
48	17	35

Dcc = Dynamic conditional correlation
Source: Research Findings

The results indicate that, in most cases, the dynamic conditional correlation between two simultaneous time series was higher than the dynamic conditional correlation with a one-day interval. This finding suggests the presence of rapid information circulation in the Iranian currency exchange market. Consequently, when two series are identical regarding their timing, i.e., dcc0, the Iranian currency exchange market plays an immediate role. Furthermore, it can be argued that when the dynamic conditional correlation of the Iranian currency exchange with the series of the next day, i.e., dcc+1, was higher, the Iran's free market dollar has been more affected than the Iranian currency exchange dollar. Conversely, when the dynamic conditional correlation of Iran's free market dollar with the Iranian currency exchange dollar series one day later, i.e., DCC-1, was higher, Iran's free dollar market had a greater impact on the Iranian currency exchange dollar.

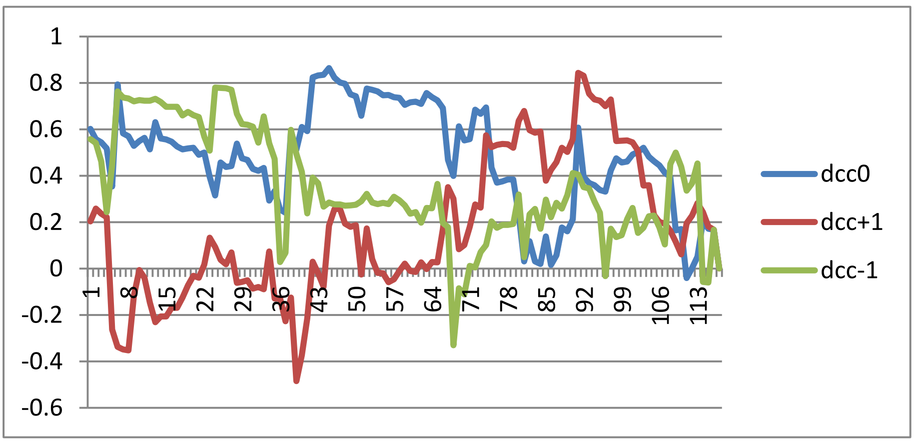

Figure 1. Dynamic conditional correlation between Iran's free dollar market and the Iranian currency exchange market at the same time and with an interval of one day
Source: Research Findings

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Based on the findings of the article, it can be argued that measuring the performance of Iran's currency exchange market is crucial for understanding its impact on the overall economy. The use of dynamic conditional correlation (DCC) methodology in this study provides a more precise and nuanced analysis of the relationship between Iran's free-market dollar and Iran's currency exchange dollar.

The results of the study demonstrate that there is a significant correlation between the two-time series, with DCC0 showing a 48% correlation between Iran's free-market dollar and Iran's currency exchange dollar on simultaneous days. This finding suggests that the currency exchange market reacts promptly to changes in the free-market dollar, indicating that the market is efficient and responsive.

Furthermore, the study reveals that the dynamic conditional correlation of Iran's free-market dollar with a one-day delay in Iran's currency exchange market was approximately 35% (DCC-1), while the dynamic conditional correlation of the Iranian currency exchange market with Iran's free dollar market one day later was almost 17% (dcc+1). These correlations suggest that there is rapid information circulation in the Iranian currency exchange market, which may impact the value of Iran's currency.

Overall, these findings underscore the importance of monitoring the performance of Iran's currency exchange market through dynamic conditional correlation. By providing a more precise measurement of the relationship between Iran's free-market dollar and Iran's currency exchange dollar, policymakers and market analysts can better understand how changes in the market may impact the overall economy. Therefore, this study highlights the need for continued monitoring and analysis of Iran's currency exchange market to ensure its stability and efficiency.

5 Conclusion

In recent years, the Central Bank of Iran has established an official market for currency exchange called the Iranian Currency Exchange to reduce the volume of currency exchanges in non-sanctioned markets. This study aims to measure the performance of the Iranian Currency Exchange in three different time forms, including the time series t0 of the Iranian Currency Exchange dollar with the time series t0 of Iran's free-market dollar (dcc0), dynamic conditional correlation time series t0 of the Iranian Currency Exchange with Time series t1 of Iran's free-market dollar (dcc+1), and dynamic conditional correlation time series t0 of Iran's free-market dollar with time series t1 of the Iranian

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Currency Exchange dollar (dcc-1), using dynamic conditional correlation methodology.

The innovative aspect of this research is monitoring the performance of the Iranian Currency Exchange using dynamic conditional correlation. The findings indicate that in 48% of cases, the Iranian Currency Exchange market exhibited dcc0 or a prompt reaction to Iran's free-market dollar, while dcc+1 of Iran's free-market dollar was observed in 17% of cases, and Iran's free-market dollar played a role in dcc-1 in 35% of cases.

This research introduced the three modes of dcc0, dcc+1, and dcc-1 to measure the performance of the Iranian Currency Exchange. Based on the data analysis using dynamic conditional correlation, the total amount of dynamic conditional correlation of simultaneous days and dynamic conditional correlation time series t0 of the Iranian Currency Exchange with time series t1 of Iran's free-market dollar was higher than the dynamic conditional correlation time series t0 of Iran's free-market dollar with the time series t1 of the Iranian Currency Exchange. In other words, considering that the sum of dcc0 and dcc+1 (65%) was more than dcc-1 (35%), it can be concluded that the Iranian Currency Exchange has acceptable performance.

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